Real-time communication – reflecting on the future
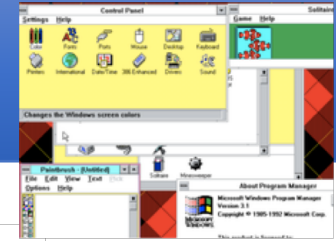
Henning Schulzrinne

Columbia University

The past isn't

25 years ago

Mosaic 1.0: November 1993

Euro-ISDN: 1994
DSL patent: 1990
DOCSIS started 1995
DSL in Germany: 7/1999

Display	4.5 in × 1.4 in (114 mm × 36 mm), 160 × 293 pixel CGA monochrome backlit LCD
Connectivity	2400-bps Hayes-compatible modem 33-pin connector 9600-bps Group 3 send-and-receive fax

IBM Simon (announced 11/1993)

GMD webcam (1997)

3

IETF25 (1992) looks familiar

Networks never die, they just drop nodes

* 1982

The fax of life

It's 2017. Why does American medicine still run on fax machines?

Updated by Sarah Kliff | sarah@vox.com | Oct 30, 2017, 8:00am EDT

The Communications Security, Reliability and Interoperability Council V
Final Report

Working Group 10
March 2017

CSRIC

years of rapid growth in mobile communications, the scale of SS7 approaches Internet proportions. Today, networks based on SS7 protocols manage the circuit-switched links among hundreds of carriers for wireline and wireless services and operators serving the majority of the 7.46 billion mobile subscribers worldwide as of June 2016.[3]

➔ We'll still have phone numbers and IPv4 addresses in 2047…

Random Dagstuhl slide

Lots of developments in networking
- Software-defined networks
- Data-plane programmable switches
- Network function virtualization
- Edge/fog computing
- Optical interconnects

Implementations Not protocols or algorithms

With exception of QUIC and maybe YANG, no major new protocols in last 10 years.

But even basic constants turn out to be variable

"Talking On The Phone" Hello Kitty

2,351,608 views

👍 3.4K 👎 792 ➡ SHARE ➕ SAVE •••

8

Another thing millennials ruined

Why Nobody Uses Their Phone as a Phone, Anymore

DEREK THOMPSON MAY 14, 2010

As phones have advanced, we've stopped using them as phones. Maybe that's ironic. Maybe it's totally predictable.

First, the stats: The number of text messages sent per user increased by nearly 50 percent last year, while talking minutes per user have fallen. Old-fashioned "talking" now accounts for "less than half of the traffic on mobile networks," imes.

Wondering why that millennial won't take your phone call? Here's why
Daisy Buchanan

More than 75% of UK adults own a smartphone, but a quarter never use it for calls: manners are transforming the way millennials communicate

So Generation Mute doesn't like phone calls. Good. Who wants to talk, anyway?
Andy Dawson

With millennials increasingly preferring to message, it won't be long before the call becomes a pursuit solely for cranks who like the sound of their own voice

9

A culture is disappearing

Not picking up the phone would be like someone knocking at your door and you standing behind it not answering. It was, at the very least, rude, and quite possibly sneaky or creepy or something. Besides, as the phone rang, there were always so many questions, so many things to sort out. Who was it? What did they want? Was it for ... *me*?

"Hello, Madrigal residence," I would say, and it would make sense of everything for me and whoever was on the other end of the line.

This became a kind of cultural commons that people could draw on to understand communicating *through* a technology. When you called someone, if the person was there, they would pick up, they would say hello. If someone called you, if you were there, you would pick up, you would say hello. That was just how phones worked. The *expectation of pickup* was what made phones a synchronous medium.

I attach no special value to it. There's no need to return to the pure state of 1980s telephonic culture. It's just something that happened, like lichen growing on rocks in the tundra, or bacteria breaking down a fallen peach. Life did its thing, on and in the inanimate substrate. But I want to dwell on the existence of this cultural layer, because it is disappearing.

No one picks up the phone anymore. Even many businesses do everything they can to avoid picking up the phone. Of the 50 or so calls I received in the last month, I might have picked up four or five times. The reflex of answering—built so deeply into people who grew up in 20th-century telephonic culture—is gone.

TECHNOLOGY

Why No One Answers Their Phone Anymore

Telephone culture is disappearing.

10
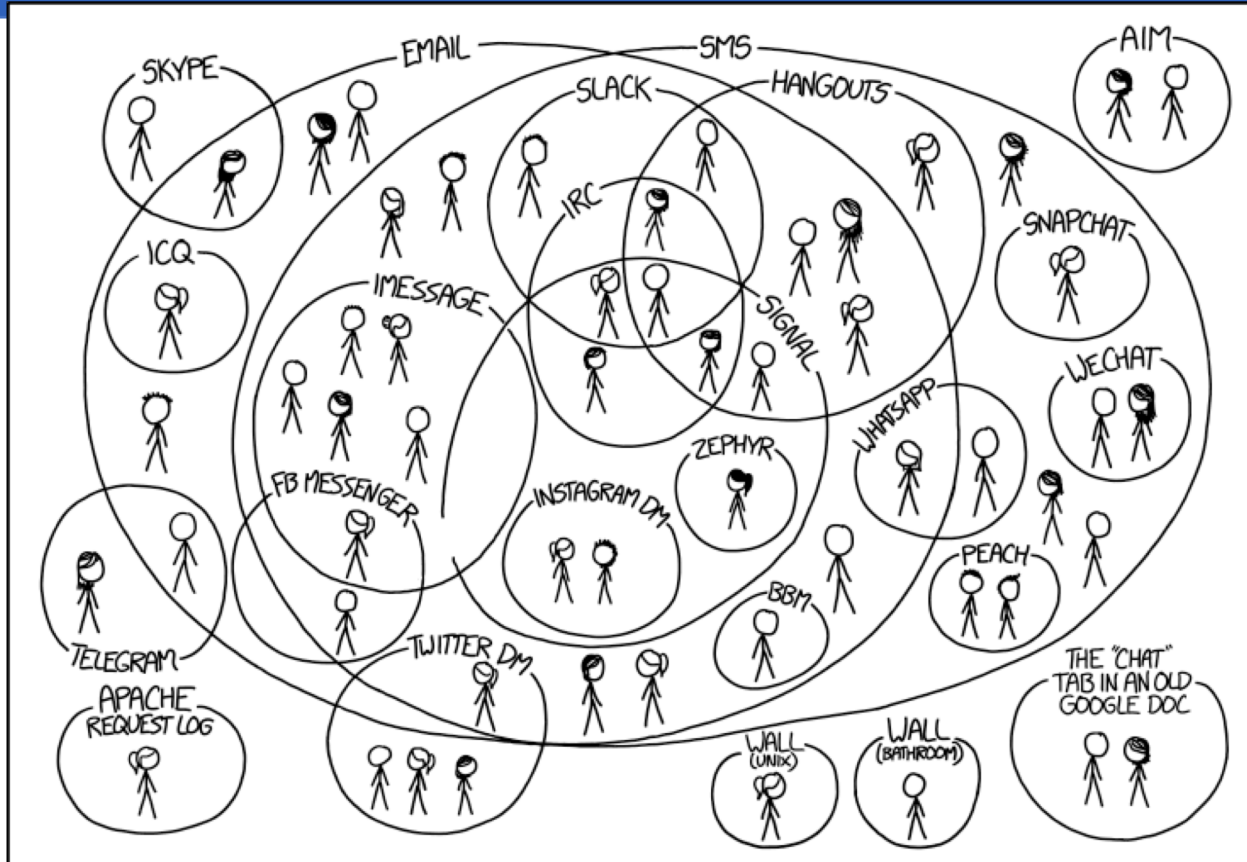
Chat systems

I HAVE A HARD TIME KEEPING TRACK OF WHICH CONTACTS USE WHICH CHAT SYSTEMS.

March 2017

11

Text messaging most popular application (2015)

Legend: 18-29, 30-49, 50+

Application	18-29	30-49	50+
Text messaging	100	98	92
Internet use	97	90	80
Voice/video calls	93	91	94
Email	91	87	87
SNS	91	77	55
Video	75	46	31
Music	64	39	21
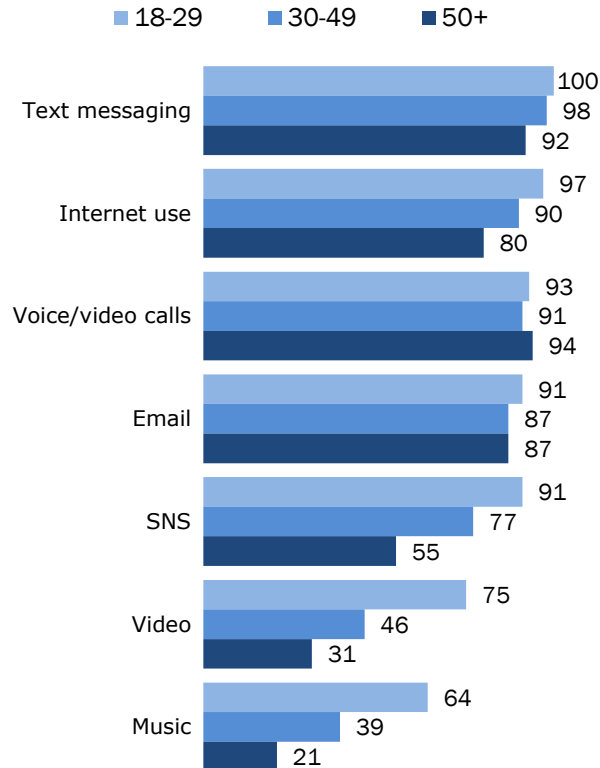
Pew Research, 2015

"We don't want to be bit pipes"

'We don't need your Internet. There is no way we can make money on it. We don't want to be just dumb pipes!'

France Telecom
Minitel era (~2000)

→ Avoid commoditization (competition on price only)

Two mechanisms: provide better services vs. withhold services ("APIs") or price-differe

chief executive Arun Sarin who cautioned mobile carriers that "<u>we must not allow ourselves to become bit-pipes and let somebody else do the services work.</u>" 2008

WAP	IMS	Linear video	Cloud	Content

Which prevents them from being *good* bit pipes
→ unusual, but inherent, conflict of interest between provider and customer

You said you wanted to be more than pipes?

Opportunity	Attempt	Solution
Programmable services	JAIN API	Twilio, Bandwidth, ...
Location	OneAPI, SUPL	AML (app data over SMS)
HD audio	IMS (VoLTE)	Anything but phone
Prevent spam	STIR/SHAKEN (2019?)	Nomorobo
Texting	SMS	WhatsApp, FB messenger, iMessage
Identity	SIM	2FA (Duo)
Privacy	Supercookie	Signal, Telegram
Emergency calling	CAMA trunks, NG911	RapidSOS
Publish/subscribe	SIP	MQTT
Universal access	Separate VRS, IPCTS	Skype with transcriptions

A reflection on the design of SIP

The Internet architectural evolution

Simple core protocols have acquired technical debts

RFC	Type	Status	Title	Bgnd	Prot	Names	Ops	RR	Proxy	Stub	Auth	Res	Xfr	DDNS	DNSSEC
882		Obsolete	Domain Names – Concepts and Facilities	x		x	x				x				
883		Obsolete	Domain Names – Implementation and Specification		x		x	x			x	x			
920			Domain Requirements				x								
973		Obsolete	Domain System Changes and Observations			x		x			x	x			
1032			Domain Administrators Guide				x								
1033			Domain Administrators Operations Guide				x								
1034	Standard		Domain Names – Concepts and Facilities	x		x	x			x	x	x			
1035	Standard		Domain Names – Implementation and Specification		x	x		x			x	x	x		
1101			DNS Encoding of Network Names and Other Types			x									
1123	Standard		Requirements for Internet Hosts – Application and Support	x							x	x			
1178	Informational		Choosing a Name for Your Computer				x								

DNS:
~143 active RFCs

17

394 SIP (and related) RFCs (incomplete)

March 1999

June 2002

SIP Standards

Core SIP Documents

RFC	Document Title
RFC 2543	SIP: Session Initiation Protocol (obsolete)
RFC 3261	SIP: Session Initiation Protocol
RFC 3262	Reliability of Provisional Responses
RFC 3263	Locating SIP Servers
RFC 3265	SIP-Specific Event Notification
RFC 5954	Essential Correction for IPv6 ABNF and URI Comparison in RFC 3261

SDP-Related Documents

RFC	Document Title
RFC 2327	Session Description Protocol (SDP) (obsolete: see RFC 4566)
RFC 3264	An Offer/Answer Model with the Session Description Protocol (SDP)
RFC 3266	Support of IPv6 in SDP
RFC 3388	Grouping Media Lines in SDP (obsolete: see |RFC 5888|)
RFC 3407	Session Description Protocol (SDP) Simple Capability Declaration
RFC 3524	Mapping of Media Streams to Resource Reservation Flows
RFC 3556	SDP Bandwidth Modifiers for RTCP Bandwidth
RFC 3605	Real Time Control Protocol (RTCP) attribute in Session Description Protocol (SDP)
RFC 3890	A Transport Independent Bandwidth Modifier
RFC 4091	An Alternative NAT Semantics for SDP
RFC 4145	TCP-Based Media Transport in the SDP
RFC 4566	Session Description Protocol (SDP)
RFC 4567	Key Management Extensions for SDP and RTSP
RFC 4568	SDP Security Descriptions for Media Streams
RFC 4570	SDP Source Filters
RFC 4572	Connection-Oriented Media Transport over TLS in SDP
RFC 4574	SDP Label Attribute

roughly 300 with SIP in title (RFC editor)

IMS 23.228: 329 pg.
RCS 5.1: 482 pg.

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What turned out well?

- Separation into SIP, SDP and RTP
- Naming flexibility (tel: URLs, numeric and email-style SIP URLs)
- Extensibility (`OPTIONS`, header structure, `Supported`)
  - except P-headers
  - but leads to profiles
  - can't keep devices from interfering with extensions
- Registration
- Forking ("simultaneous ringing") → Nomorobo
- Support of different forwarding models (redirection, B2BUA, proxy)
- Some diagnostics
 - OPTIONS, Via, History-Info, …

What's been challenging?

- Handling NATs
  - ICE works, but complex
  - signaling co-located media relays seem common
- Application-layer security
  - end-to-end
  - entity authentication (callers, intermediaries)
- Complexity
  - almost all use with profiles (cf. SMTP and HTTP!)
- Presence
  - real-time privacy concerns
  - user value beyond "typing" indicator?

Missed policy opportunities

- Mandatory interconnect with VoIP
  - See Kingsbury, §251 of Communications Act (1934)
  - including for NG911
- Faster regulatory action → avoid voice as toxic waste dump and damaged goods
  - robocall RFC: 2008
  - FTC robocall summit: October 2012
  - first, the FCC believed the carriers
  - then, they believed their deregulatory philosophy ("no mandates")
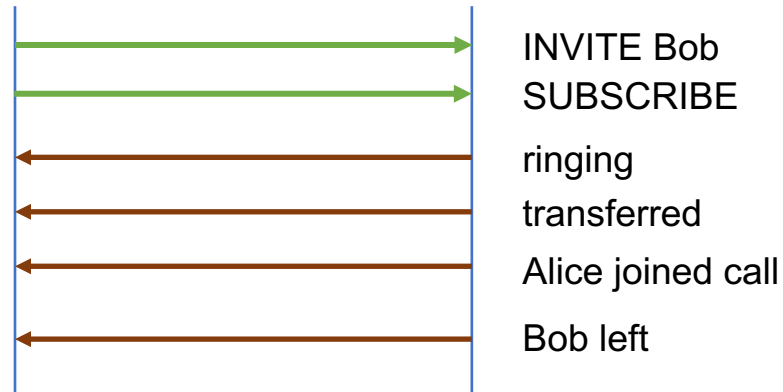
VoLTE subscriptions by region (billion)
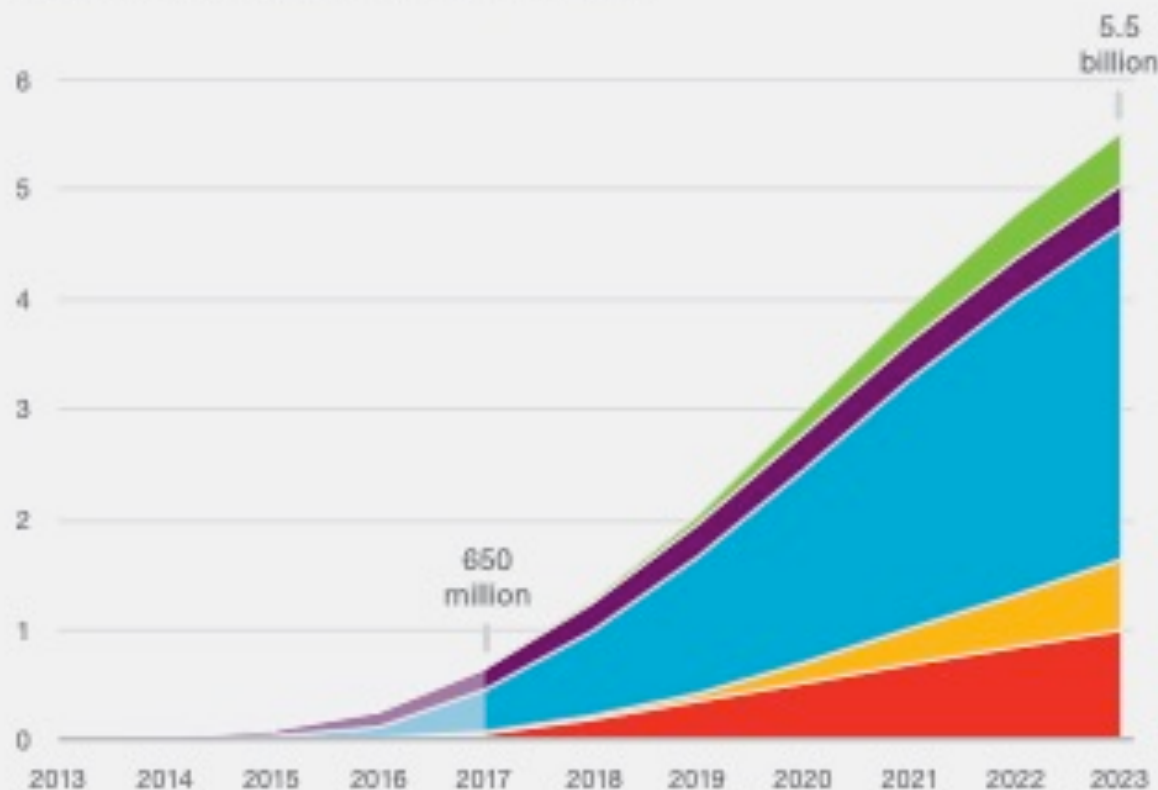
VoLTE subscriptions are expected to reach 5.5 billion in 2023

Latin America
North America
Asia Pacific
Middle East and Africa
Europe

22

What would I do differently in 2018?

- SIP reliability + UDP → layered
  - necessary to get the protocol deployed initially
  - concerns about simultaneous connections
- SDP with more extensible syntax
- Built-in signing model (STIR baked in)
- Build on "promise" model – asynchronous publish-subscribe
  - pub/sub as infrastructure
  - retain connection

JSON or CBOR

SIP

pub/sub request

QUIC

INVITE Bob
SUBSCRIBE
ringing
transferred
Alice joined call
Bob left

Robocalls should have surprised nobody

"You won the Nobel prize. You just have to wire some money."

When the Swedish Royal Academy of Sciences called New York University professor Paul Romer early this morning to inform him that he was co-recipient of this year's Nobel Prize in Economics, the veteran professor let the call go to voicemail, thinking that only a telemarketing call could be coming in at such an early hour.

"I didn't answer the phone because I've been getting so many spam calls," Romer told ABC News. "I just assumed it was more spam."

Nearly half of all cellphone calls next year will come from scammers, according to First Orion, a company that provides phone carriers and their customers caller ID and call blocking technology.

The Arkansas-based firm projects an explosion of incoming spam calls, marking a leap from 3.7 percent of total calls in 2017 to more than 29 percent this year, to a projected 45 percent by early 2019.

All open communications media attract spam

1996: US Standard Mail (bulk mail) created
2005: Standard Mail volume outpaces First-Class Mail volume
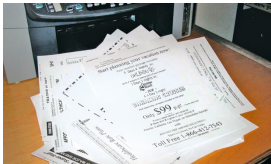
1985: invention of computer-based fax board
2005: Junk Fax Prevention Act (47 USC 227)

```
WE INVITE YOU TO COME SEE THE 2020 AND HEAR ABOUT THE DECSYSTEM-20 FAMILY
AT THE TWO PRODUCT PRESENTATIONS WE WILL BE GIVING IN CALIFORNIA THIS
MONTH.  THE LOCATIONS WILL BE:

        TUESDAY, MAY 9, 1978 - 2 PM
            HYATT HOUSE (NEAR THE L.A. AIRPORT)
            LOS ANGELES, CA

        THURSDAY, MAY 11, 1978 - 2 PM
            DUNFEY'S ROYAL COACH
            SAN MATEO, CA
            (4 MILES SOUTH OF S.F. AIRPORT AT BAYSHORE, RT 101 AND RT 92)

A 2020 WILL BE THERE FOR YOU TO VIEW. ALSO TERMINALS ON-LINE TO OTHER
DECSYSTEM-20 SYSTEMS THROUGH THE ARPANET. IF YOU ARE UNABLE TO ATTEND,
PLEASE FEEL FREE TO CONTACT THE NEAREST DEC OFFICE
FOR MORE INFORMATION ABOUT THE EXCITING DECSYSTEM-20 FAMILY.
```

1978: email spam (DEC-20)
Jan 1994: "Global Alert For all: Jesus is Coming Soon:
April 1994: Canter & Siegel green card lottery
1994: MAKE MONEY FAST!

```
Path: gmd.de!urmel.informatik.rwth-aachen.de!newsserver.rrzn.uni-hannover.de!hrz-ws11.
From: ni...@indirect.com (Laurence Canter)
Newsgroups: alt.bonehead.paul-hendry,alt.online-service.america-online
Subject: Green Card Lottery- Final One?
Date: 12 Apr 1994 07:40:23 GMT
Organization: Canter & Siegel
Lines: 34
Message-ID: <2odj97$25f@herald.indirect.com>
NNTP-Posting-Host: id1.indirect.com

Green Card Lottery 1994 May Be The Last One!
THE DEADLINE HAS BEEN ANNOUNCED.
```

Telegraph spam - 1864

The etiquette of telecommunications

Getting the message, at last

A parable of manners from Victorian dentists to modern airlines

Dec 13th 2007

ON A May evening in 1864, several British politicians were disturbed by a knock at the door and the delivery of a telegram—a most unusual occurrence at such a late hour. Had war broken out? Had the queen been taken ill? They ripped open the envelopes and were surprised to find a message relating not to some national calamity, but to dentistry. Messrs Gabriel, of 27 Harley Street, advised that their dental practice would be open from 10am to 5pm until October. Infuriated, some of the recipients of this unsolicited message wrote to the *Times*. "I have never had any dealings with Messrs Gabriel," thundered one of them, "and beg to know by what right do they disturb me by a telegram which is simply the medium of advertisement?" The *Times* helpfully reprinted the offending telegram, providing its senders with further free publicity.

SIP spam

INFORMATIONAL

Network Working Group   J. Rosenberg
Request for Comments: 5039   C. Jennings
Category: Informational   Cisco
                                                        January 2008

The Session Initiation Protocol (SIP) and Spam

Status of This Memo

   This memo provides information for the Internet community. It does
   not specify an Internet standard of any kind. Distribution of this
   memo is unlimited.

Abstract

   Spam, defined as the transmission of bulk unsolicited messages, has
   plagued Internet email. Unfortunately, spam is not limited to email.
   It can affect any system that enables user-to-user communications.
   The Session Initiation Protocol (SIP) defines a system for user-to-
   user multimedia communications. Therefore, it is susceptible to
   spam, just as email is. In this document, we analyze the problem of
   spam in SIP. We first identify the ways in which the problem is the
   same and the ways in which it is different from email. We then
   examine the various possible solutions that have been discussed for
   email and consider their applicability to SIP.

28

Unusual VoIP (& SIP) usage

Example: DARPA PHOENIX nodes

DARPA RADICS: support blackstart for electric utilities

802.11af
(TVWS)

high-bandwidth
VHF

DECT

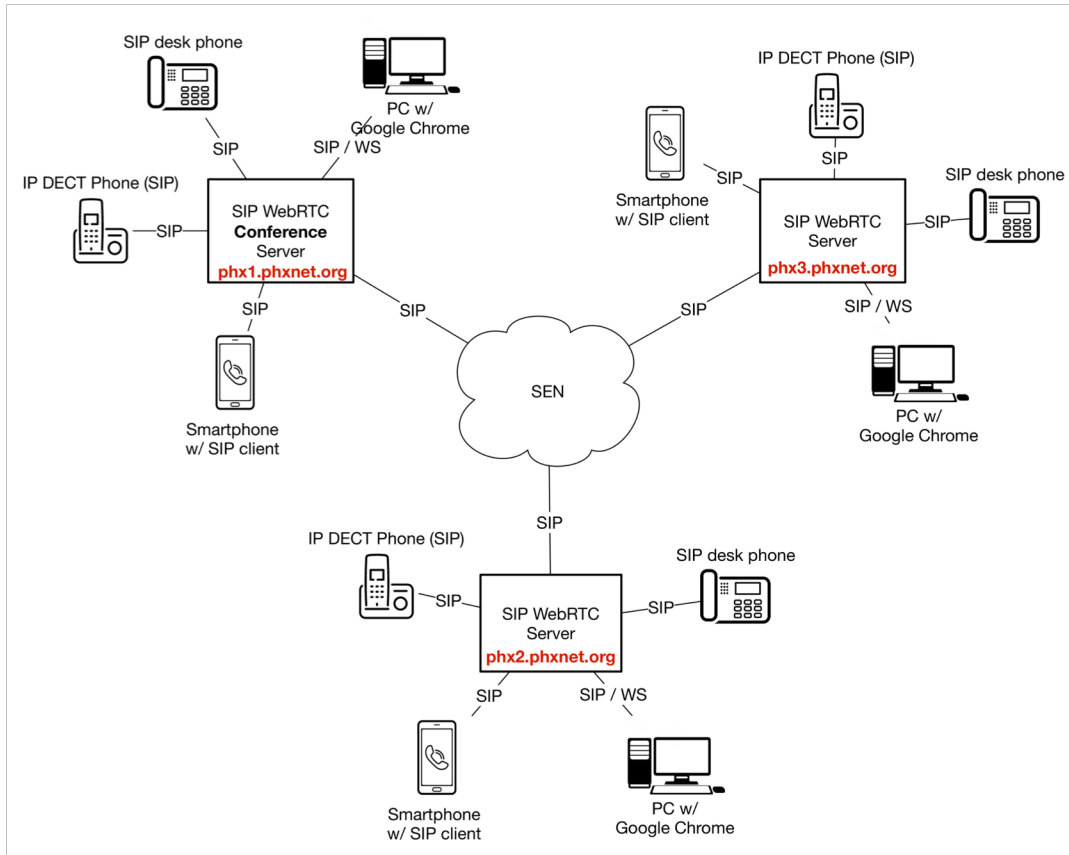SDR: P.25
over VHF + Codec2 + data

- mesh network (OLSR)
- self-configuring – just turn on
- network-technology agnostic (not just 4G)
- local services (VoIP, messaging, edge cloud)
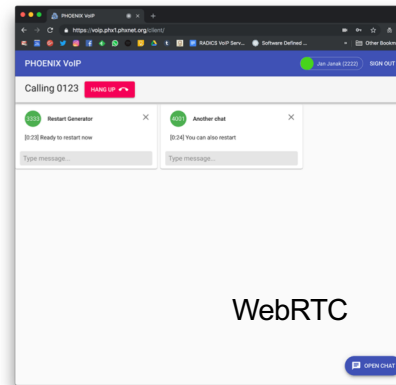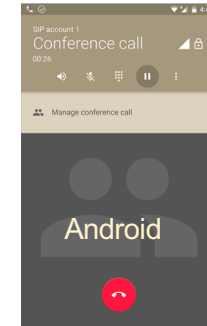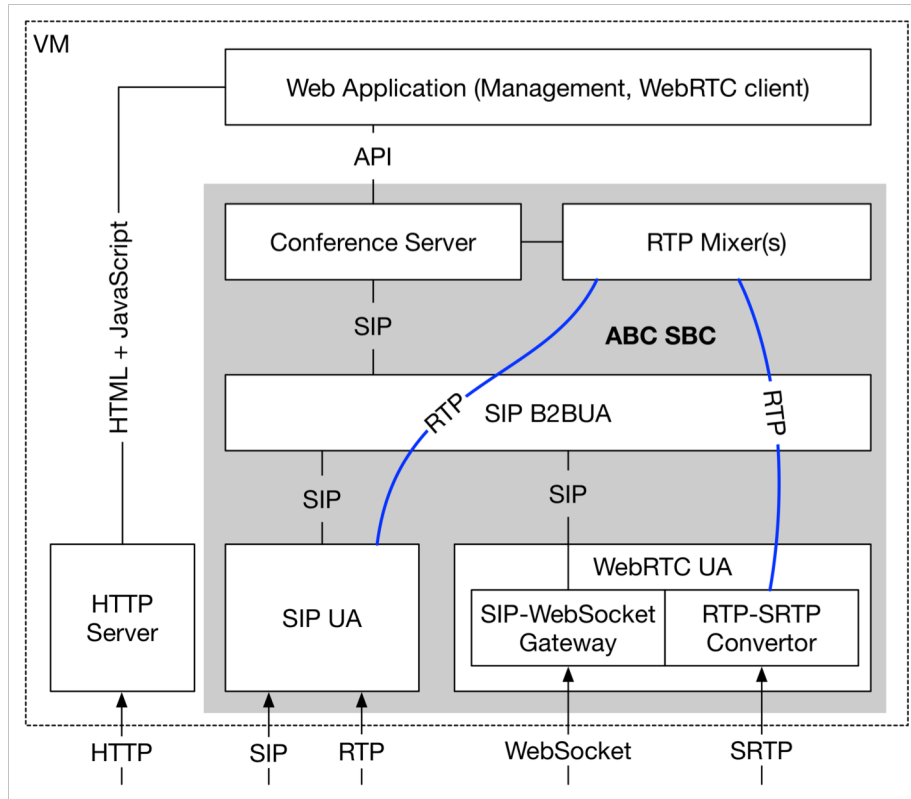- with diagnostics and traffic isolation

30
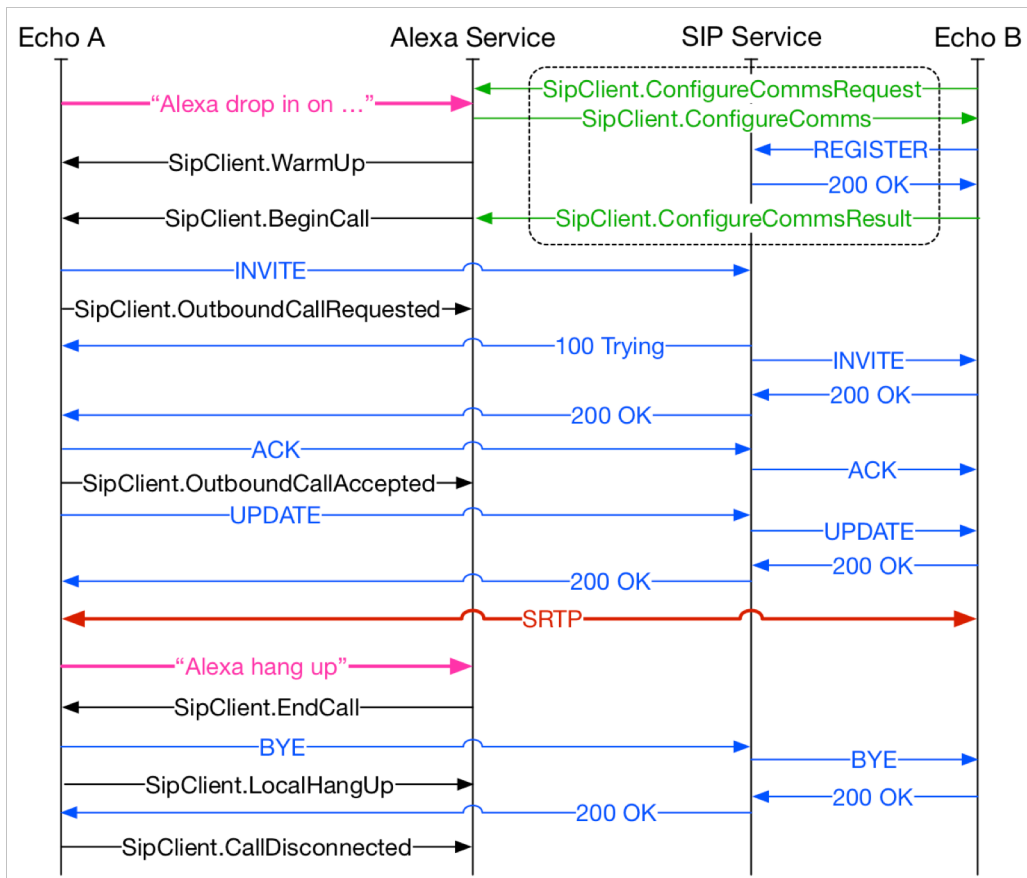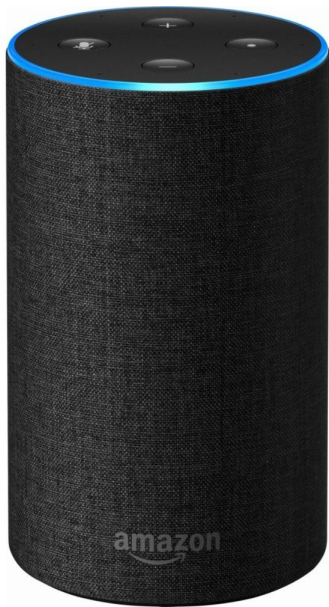
Every node can function by itself
Local capability, "global" dial plan

WebRTC

Android

Amazon Echo speaks SIP

MTA Help Point

Help Point Features

- Blue LED Beacons
- Two Push Buttons – Red and Green
- Speaker
- Microphone
- SIP VOIP Intercom Induction Loop Driver and Coil
- Cyber Lock Assembly

Group communication

Still does not work well

- Remote participants are second-class
- Phone participants must be rude
- "Can you mute your phone?"

One of the main features coded into Google Hangouts and Apple's new Group FaceTime is that when someone is talking, their image becomes really big. Those who aren't talking become small. The idea, in theory, is that it makes it possible to focus on the person speaking.

But it also rewards the loudest person in the room—echoing one of the dreariest problems that already infects everyday face-to-face groupings. You know from any meeting, conference panel, or late-night drinks that the

Setting up a temporary team

- Create a mailing list on Outlook
- Share a Dropbox folder
- Send around calendar invites by email
- Find free time slots using Doodle
- Copy-paste email addresses into WebEx setup
- Share a Google Doc by emailed link
- Set up a Github repository for the group
- ➔ all manual, all tedious
- integrated options all assume you want their solution to be the boss

Phone numbers as identities

Phone numbers are the least bad identifier

LILY HAY NEWMAN   SECURITY   08.25.18   07:00 AM

PHONE NUMBERS WERE NEVER MEANT AS ID. NOW WE'RE ALL AT RISK

try spelling your email address at the grocery store cashier

Your phone number is becoming the online identifier of choice

Phone numbers as identifiers

That's because phone numbers have become more than just a way to contact someone. In recent years, more and more companies and services have come to rely on smartphones to confirm—or "authenticate"—users. In theory, this makes sense; an attacker might get your passwords, but it's much harder for them to get physical access to your phone. (WIRED)

- Passwords are already obsolete → password recovery via email or SMS
- Secure signaling channel (e.g., SIP)
- Prevent SIM swapping (e.g., check ID, facial recognition)
- STIR/SHAKEN provides additional options (user certificate!)

~~What you know~~
What you have (phone)
What you are (phone biometrics)

2015551234

10:40
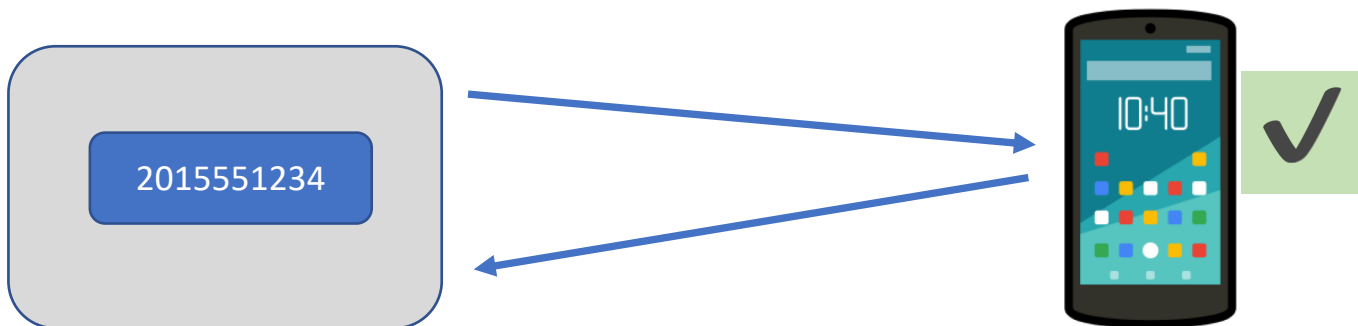
Conclusions

- It's a small world after all
- We should have learned (and acted) faster in many cases
  - loss of function, interoperability, privacy
- There's room for improvement for even core functions
  - conferencing, team work, even phone calls
- And there's always ML & blockchain + VoIP to work on